# Aortic Stenosis

## Surgical Treatment Under Direct Vision, Using the Heart-Lung Machine

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• **Cardiac operation with the operative field under direct vision and the patient's oxygenation maintained by a heart-lung machine affords an excellent means of treating aortic stenosis, for it allows unlimited time in which to repair aortic stenosis no matter how involved the cusps are with calcium. The valves can be sculptured and the commissures cut at their place of fusion. Concomitant aortic insufficiency can also be taken care of at the same time, as can associated mitral valve stenosis and insufficiency.**

**This method was used in ten patients. Two died. Eight were considerably improved.**

VARIOUS METHODS for the surgical correction of aortic stenosis have been suggested since Tuffier[10] first described his method of aortic commissurotomy in 1913. In 1956 Bailey and co-workers[1] reported their experiences with aortic commissurotomy, first by passing a dilator retrograde through the carotid artery into the stenotic aortic valve and then by using the transventricular approach to the valve. Both techniques were abandoned for the transaortic route utilizing a pouch made of either preserved pericardial homograft or plastic cloth sewed on the ascending aorta. This "blind" technique (carried out without the surgeon's being able to see the lesion), consisted of passing a finger into the pouch and on into the aorta with an attempt to dilate the stenotic valve. In the last two years, many papers on aortic commissurotomy by this closed technique have been published. In 1959, Harken and co-workers[4] still advocated transaortic valvuloplasty using an operating tunnel made of the plastic material Ivalon®. And as recently as 1958, Glover and Gadboys[3] recommended transventricular aortic commissurotomy.

The visual repair of aortic stenosis under hypothermia was reported experimentally by Kaiser, Gaertner and Kay[5] in 1956. A report on the first ten patients operated upon by this technique was made by Kay, Anderson and Sheinkopf[6] in 1958. Work along the same line was also being performed by Lewis, Shumway, Niazi and Benjamin[7] in 1956 and Swan, Wilkinson and Blount[9] in 1958. Lillehei, DeWall, Gott and Varco[8] were the first to report on correction of aortic stenosis under direct vision, using the heart-lung machine. More recently, Bailey, Musser and Morse[2] reported on valvuloplasty with their "sculpturing" technique in cases of aortic stenosis.

The following is a report on the first ten consecutive patients with aortic stenosis operated upon with use of the Kay-Anderson heart-lung machine. The patients had rheumatic as well as congenital aortic stenosis and in two patients there was severe calcification of all cusps, necessitating use of "sculpturing" technique. The calcium was 1 to 1½ cm. thick on these cusps and before the sculpturing was carried out the cusps were immobile.

The age range of the ten patients was from 2 to 50 years. Five of the cases were congenital and five of the acquired type. The clinical symptoms of all patients showed a definite progressive course. The main symptoms were shortness of breath, pain in the chest, easy fatigability, dizzy spells and syncope. Two patients were in heart failure before the operation. All but one of the patients received digitalis before operation; the exception was digitalized immediately after the procedure. Preoperative left heart catheterization was performed in seven of the patients. The studies showed significant aortic stenosis, with gradients across the aortic valve as high as 120 mm. of mercury. X-ray films of the heart and cardiac studies showed left ventricular hypertrophy in all patients. Planigrams, made in six cases, showed varying calcification of the aortic valve up to the maximum of grade IV. Electrocardiogram patterns were all consistent with left ventricular hypertrophy and strain; and, in three cases, with left auricular enlargement also.

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### TECHNIQUE OF OPERATION

A median sternotomy incision was used in all patients except the first, who had a bilateral anterior thoracotomy through the fourth intercostal space. The pericardium was opened in a longitudinal direction anteriorly. In order to prevent cardiac tamponade postoperatively and collection of blood in the mediastinum, the right edge of the pericardium was opened in a posterior direction and left wide open at the end of the procedure. This permitted blood to drain into the right pleural space and to be removed by tubes in the right side of the chest. The patient was given 3 mg. of heparin per kilogram of body weight and total body perfusion of blood was used in all cases. The venous blood was drained from the superior and inferior venae cavae and oxygenated blood was returned to the patient into the aorta through the right femoral artery. A second catheter was inserted into the left superficial femoral artery and on into the aorta for measuring pressure. During cardiopulmonary by-pass it was necessary to clamp the aorta just proximal to the innominate artery. A longitudinal incision was then made on the side of the aorta between the area of the aortic valve and the previously placed clamp on the aorta. Under direct vision the aortic valve was then repaired by removing the calcium from the cusps and performing aortic commissurotomy. In one patient, moderately severe aortic insufficiency was corrected at this time; and, in another, mitral commissurotomy was performed under direct vision following the aortic commissurotomy. The longest duration of cardiopulmonary by-pass was 149 minutes and the shortest was 35 minutes. Intermittent coronary perfusion was achieved by removing the aortic cross-clamp and tangentially excluding the aortic incision with a clamp, thus permitting perfusion of the coronary arteries. The longest total intermittent occlusion time of the aorta was 63 minutes and 30 seconds, but the average time of total occlusion of the aorta was 20 to 35 minutes.

### RESULTS

Diagnostic data and results of operation are shown in Table 1.

The following are reports on two of the more interesting patients. One patient was a 48-year-old man with combined severe aortic stenosis and moderately severe aortic insufficiency. There was a Grade IV calcification of the aortic cusps (grading ranging from I to IV, with IV the most severe). Calcium 1.5 cm. thick on all the cusps was the cause of stenosis, and insufficiency was due to the immobility of the cusps. The infundibulum of the left ventricle for a distance of 4 cm. from the aortic valve was also calcified. By "sculpturing," the calcium was removed from the dorsum of all the aortic cusps. Although this corrected the stenosis, there was still moderate insufficiency. There was a good right coronary cusp but the left coronary and the noncoronary cusps were small and did not meet in the midline. These cusps were sutured together in the midline and a piece of Ivalon® sponge 2.5 cm. long, 1 cm. wide, and 3 mm. thick was attached over these two joined cusps in such a fashion that a portion of the sponge protruded past the cusps into the midline, where it overlapped the right coronary cusps. This procedure corrected the aortic insufficiency also. The duration of cardiopulmonary by-pass was 1 hour and 49 minutes. Postoperatively tracheotomy was done because of tracheobronchial secretions. The patient did well thereafter.

The second patient was a 50-year-old man with combined aortic and mitral stenosis. X-ray films of the chest showed left ventricular and atrial enlargement and planigrams demonstrated Grade III calcification of the aortic and of the mitral valve. A gra-

**TABLE 1.—*Data on Diagnosis and Results of Direct Vision Operation with Use of Heart-Lung Machine***

| Date of Operation | Age in Years | Diagnosis | Left Heart Cath. Aortic Gradient (in mm. Mercury) | Planigram | Result |
|---|---|---|---|---|---|
| Sept. 22, 1958 | 47 | Rheumatic: Aortic stenosis | 60 | Not done | Good |
| March 5, 1959 | 2 | Congenital: Aortic stenosis, endocardial fibroelastosis | Not done | Not done | Died |
| April 1, 1959 | 2 | Congenital: Aortic stenosis | 55 | Not done | Good |
| June 9, 1959 | 41 | Rheumatic: Aortic stenosis | 40 | Grade I | Good |
| May, 1959, Israel | 16 | Congenital: Aortic stenosis | Not done | No calcification | Good |
| May, 1959, Israel | 38 | Rheumatic: Aortic stenosis | Not done | No calcification | Good |
| July 21, 1959 | 48 | Rheumatic: Aortic stenosis, aortic insufficiency | 85 | Grade IV | Good |
| July 28, 1959 | 50 | Rheumatic: Aortic stenosis, mitral stenosis | 55 | III Aortic, III Mitral | Good |
| July 31, 1959 | 43 | Rheumatic and Congenital: Subaortic stenosis, mitral insufficiency | 90 | None | Died |
| Aug. 7, 1959 | 16 | Congenital: Aortic stenosis | 120 | Not done | Good |

dient of 55 mm. of mercury across the aortic valve and 20 mm. across the mitral valve was demonstrated by left heart catheterization. At the time of operation the ascending aorta was opened and fusion with calcification of the right coronary and noncoronary cusps was noted. The left coronary cusp was also calcified. The aortic opening was 1 cm. in diameter. Valvuloplasty with "sculpturing" was done, the removal of calcium making the cusps mobile and increasing the aortic opening to 2 cm. The left atrium was opened and pronounced mitral stenosis was noted, opening in the mitral valve being 8 mm. in diameter. There was calcification of the anterolateral commissure but the posteromedial commissure was not affected. Commissurotomy was performed, the opening in the center of the mitral valve being increased to 3 cm. Cardiopulmonary bypass was maintained for 2 hours and 5 minutes. The postoperative course was uneventful.

Eight of the ten patients in the series were considerably improved by the operation. Two died. One of them was a two-year-old child with endocardial fibroelastosis and aortic stenosis. The aortic commissurotomy was done and the patient appeared to be doing well but as the chest was being closed ventricular tachycardia and fibrillation developed. It was impossible to restore normal beat despite all attempts, including returning to cardiopulmonary by-pass for two more hours. The other patient who died was a 43-year-old woman with subaortic stenosis caused by hypertrophy of the left ventricular muscle of the entire left ventricle. This resulted in obstruction of the outflow tract. The aortic valves were normal. The patient also had mitral insufficiency, which was treated at the time of operation. In removing the muscle mass causing the obstruction, the conduction system was injured and complete heart block ensued. Despite the use of an internal pacemaker and postoperative care, the blood pressure could not be maintained postoperatively and the patient died 24 hours after operation.

The method used in this series is far superior to the hypothermic method that was previously used by the authors. There would seem now to be no place for the "blind" methods of aortic commissurotomy either by the transventricular or transaortic route. It is of interest that during the period in which the ten patients in the present series were operated upon, another three patients who had been placed on the operative schedule died before operation. This would suggest the extreme hazard of this disease and the necessity for prompt operation once symptoms begin.

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